Shackling the Flood Devils of the Miami

THE eyes of the engineering world are turned today toward the Miami Valley of Ohio, where there is being carried on the greatest flood protection project under construction in any part of the world. Engineers have come from China and Japan, from almost every country of Europe, from South America and from all corners of our own United States to study the materialization of the ingenious plans, formulated by the greatest engineering talent of this country, to save one of the most fertile of America's garden spots from the horrors and losses of the great floods which have so often laid it waste.

Although the impelling motive which fostered the creation of the Miami Conservancy District and the work which is being done under its authority was the great flood of 1913, the valley has always been subject to disasters of this kind and has been swept time and again by disastrous periods of high water. The records show that there has been a great flood in the Miami region at least once in every ten years and that on many other occasions the water has been high enough to cause great loss throughout the rural districts.

The Miami drainage basin lies in Southwestern Ohio. It has an area of 4,000 square miles, including all or parts of 15 counties, eight cities or villages and thousands of highly developed and very productive farms. The chief tributary streams of the Miami River are Mad River, Stillwater River, Four Mile Creek, Twin Creek and Loramie Creek. The Miami is something over 150 miles long, extending from the Lewiston reservoir to a point 20 miles below Cincinnati where it joins the Ohio.

Dayton, the principal city, lies just below the confluence of the Stillwater, Mad and Miami rivers while Hamilton is in a still more vulnerable position since Twin Creek, which is a vicious stream in the time of heavy rains, empties into the Miami River above the city and adds greatly to the flood problem of this community.

Excessive rainfall in the valley is always the forerunner of flood waters. This is due partially to the soil composition and partially to the exceedingly large number of drainage ditches which, while they improve thousands of acres of land, carry the water off very rapidly and turn the normally placid tributary streams of the main river to raging torrents overnight. The bed of the Miami is not proportioned to care for excessive discharges and the natural result is that even a moderate flood causes it to overflow its banks and spread across the lowlands, while any such flow as that experienced during the several high water periods of the valley's history always results in great damage.

The first agitation for flood prevention works arose in the cities of Hamilton and Dayton and both of these communities summoned experts to study the situation with the view to making channel improvements which would carry the flood waters by. In the course of the surveys it was discovered that while this method promised the earliest results it was not an adequate solution of the problem. In the first place the river channels in and about the cities had a capacity of only 33 per cent of the 1913 flood, and the work of enlarging them meant the expenditure of millions of dollars in grade changes, the construction of levees and bridges and the destruction of a vast amount of highly developed property.

In addition to this feature, it was apparent that such channel improvements would offer no protection to the valley at large but would merely serve to hurry the waters through the cities and spread them upon the defenseless agricultural lands. Enlargement of the channel throughout the entire valley was not practical because it would mean a 90 per cent addition to the present river bed for a distance of approximately 150 miles, an expense which would be prohibitive.

The cities, considering all of these things, decided to sacrifice their immediate safety for the sake of safeguarding the whole valley through some comprehensive plan of flood prevention and instructed their engineers to make studies to that end. The people were quite well aware, when they took this step, that it meant a delay in safeguarding their own interests and that it meant also they would bear a heavy burden of taxes for improvements spent in protecting property other than their own. It is to their everlasting credit that they chose the big and the broad way, restraining their impatience to see dirt flying immediately and counting the community gain rather than the private cost.

The plan finally recommended and adopted consists of a series of five retarding basins or reservoirs formed by building dams across the valleys of the Miami and its tributaries. There are permanent conduits in the base of the dams through which the streams flow at their normal rate in ordinary times.

The theory of the project is that when heavy rainfalls create a flood and the rivers rise these conduits will permit the water to pass downstream only as rapidly as the river channels can accommodate it while all in excess of this will accumulate in the retarding basins behind the dams. The result will be that a flood like that of 1913, in which almost one and one-half million acre feet of water rushed down the valley in four days, will now be held back by the dams, stored in the reservoirs and released gradually over a period of two weeks or more.

These five reservoirs will have a capacity of 900,000 acre feet of water (an acre foot is the amount of water necessary to cover one acre of land to the depth of one foot) or 60 per cent of the total amount of water that passed down the valley in the flood of 1913. This, with the discharging capacity of the permanent conduits at the base of the dam, will enable the retarding basins to control a flood 40 per cent greater than that of 1913, assuring what the engineers believe to be an adequate margin of safety under any possible conditions.

There were several factors favorable to such a plan as this. One was the existence of natural basins in the valleys, another was the fact that the composition of the soil was excellent for the construction of earth dams and a third was the presence of natural foundations of bedrock at strategic points for the construction of spillways and conduits.

The finest engineering talent of the country was summoned to the valley to test the theory of this plan, and before a single dollar had been spent on equipment or the first dirt thrown, the District had received repeated assurances that it was on the right road.

Practically five years were spent in developing the plans on which the work of construction is now proceeding, or about a year longer than it is expected the actual work of building will consume. "Make sure you're right then go ahead," was the motto of the board of directors and nothing could move them from that position. Time has proved that not a day of their deliberations was wasted because the time devoted to surveys and planning made it possible to gather a picked corps of experienced engineers, to build up the nucleus of a construction force and to determine exactly what equipment would be necessary to carry on the work. Consequently when construction work started in earnest it struck and held a pace which has shattered all previous records in tasks of this kind.

The dams, which are the most imposing part of the work to a layman because of their great size, are being built along lines developed during a long and careful study. The causes of failure in 200 dams built in the past were thoroughly analyzed and every care taken to profit by these lessons and to insure works which would stand for all time.

It may not carry much significance to the lay mind to say that nine million yards of earth and 190,000 yards of concrete will be used in the five dams and their appurtenances, but there should be no difficulty in visualizing these figures when it is explained that the lowest of the five dams is 65 feet high and 3,340 feet long while the crest of the highest dam is 120 feet above the valley and 4,660 feet in length. All the dams are 25 feet wide at the top and their crests will be used for highways. Their thickness at the valley level varies, the Huffman dam being 380 feet wide at its base, while the Englewood dam has more than three times that breadth. The outer surfaces of the slopes will be covered with soil and planted to grass and hardy shrubs. Paved gutters will care for rainfall in a manner which will preclude any danger from erosion.

The hydraulic fill method has been adopted in the building of the dams as being both superior to and more economical than the older method of roll fill. One of its advantages is that the bulk of the work is done by machinery and this is immediately noticeable to the observer who visits one of these giant works for the first time. There are fewer men in sight on the Englewood dam, which is the largest of the five, than one may sometimes see on a stretch of state road under process of construction.

The process on the Englewood dam, which is followed with small variations on all the other barriers that are being thrown across the valleys, is interesting and is easily grasped. Construction cars are filled with earth at a point above the dam known as the "borrow pit" and this material is then hauled to a position alongside the dam and dumped into a so-called "hog box" where it is washed down by hydraulic streams into a revolving "grizzly" or screen. In the screen the large stones are thrown out while the earth and gravel sifts through and is carried by the water into great pumps which hurl their contents through lines of steel pipes.

Converging streams from these pipes work from each side of the dam. The gravel being heaviest falls and comes to rest soonest while the sand and clay is carried in toward the heart of the structure and settles so that with the passing off of the water there is left an impervious core, which is flanked on each side by thick walls of stone and gravel. Thus the dam, at one operation, is endowed with both imperviousness and strength, the two qualities which are absolutely essential in a work of this kind.

If six hundred men with teams could be placed on one dam and worked to the limit of their strength they could not deliver as much material as these two pipelines are capable of doing. Rather significant of the spirit of the whole work is the way in which the valley has harnessed its ancient enemy and put it at work in defense of the lands it once despoiled.

Next to the dams themselves the feature of the work which is of the greatest interest lies in the massive concrete outlet structures. At three of the dams the outlet works and spillways are combined and at the remaining two they are completely separated but in all cases the principle of the outlets is the same. It is not believed by the engineers that the spillways will ever be necessary, but the conduits are the key of the whole project.

It is necessary that these openings, which are permanent and without gates, must be kept open, and to prevent floating masses of timber from obstructing them rows of concrete piers are to be built in the stream above while booms strongly anchored to masonry will also assist in holding back drifting debris. To prevent erosion by water, the bed of the stream as well as the toe and the slopes of the dam near the entrance to the conduits will be paved with stone.

Below the downstream end of the conduits there is built what the engineers know as a hydraulic jump. This is, in effect, an artificial channel of concrete and is constructed with a view to destroying the terrific force with which the water leaves the conduits under the heavy head developed in the retarding basins. This ingenious plan was worked out in actual detail upon small models before being adopted. As the stream is shot forth from the conduits at a rate as high as 60 feet a second, it whirls down a series of irregular steps, plunges into a deep pool of comparatively still water and almost simultaneously dashes against a massive 15-foot concrete wall and throws up a standing wave of considerable height and volume. Leaping this barrier the water falls into another pool and again strikes a strong wall which throws it into the air a second time. So thoroughly has the current been broken by this time and so greatly has its strength been dissipated in foam and spray that it leaves the last barrier comparatively tame, flowing steadily and powerfully to be sure but minus the wild velocity it possessed when it boiled forth from the conduits only a hundred feet back.

It is estimated that a flood 40 per cent greater than the one of 1913 would cover 35,600 acres of territory behind the five dams. In the beginning it was hoped that easements could be procured for a reasonable fee that would give the district the right to flood those acres which lie in the retarding basins. The owners, however, asked such a high price for the easements that the district decided it would be cheaper to buy most of the land and accordingly purchased 35,000 acres. This has since proved to be one of the best investments of the entire project. The land, lying mostly in the river bottoms, is the richest of the valley and the district lost no time in employing a farm manager and a force of men to work its new fields. Some of the remaining land has been leased, there being about 100 acres which are renting for $100 an acre while several farms have been resold at a profit to the district. The prospect seems to be that the district, because of its foresight in purchasing this land will not only make considerable profit on its holdings, but will have all the flood rights necessary and in addition to this will be richer by the creation of several hundred acres of beautiful park property along the banks of the little lakes which will be formed at four points in the valley.

It has been shown that instead of impoverishing the lands in the reservoirs the dams will be a positive benefit and will make them even richer than they are today. In the past the floods have frequently destroyed large sections of valuable farming land. In some instances the waters stripped off the top soil and in others it buried the fields under deposits of rock and gravel. In both cases the land was made useless for agricultural purposes. Now, however, with the flood waters held back by the dams and lying in comparative quiet, the rich silt which they carry will be deposited on all those acres within the retaining basins.

The benefits to be derived from this protection by 75,000 pieces of property were estimated by the board of appraisers to amount to $75,000,000. This estimate became the basis of a 30-year bond issue from which $35,000,000 was realized. Of this amount Dayton and Hamilton stand by far the greater share.

In the agricultural districts only those lands which receive a direct benefit from the flood prevention work are taxed. The cities, however, pay a general flood prevention tax and in addition to this, the owners of property which receives protection pay an additional

(Concluded on page 15)

BRIEF PARAGRAPHS ON GREAT PROJECT

The greatest flood prevention work of the kind ever attempted in the United States.

To cost $35,000,000 when completed in 1922.

District extends up the Miami Valley 100 miles, contains 8 cities and includes parts of 9 counties.

Project consists of five great dams and retarding basins supplemented by channel improvements in the cities and at other strategic points.

Permanent concrete conduits at base of dams are so proportioned that no more water can pass through them than river channels will carry away. All flood water in excess of this will be held by dams in retarding basins, and will run off gradually.

When construction is finished a flood 40 per cent greater than that of 1913 will flood one-third less territory. The 1913 flood did $100,000,000 damage in cities. A similar flow of water now will cover only the farm lands and will enrich instead of despoiling the valley.